CALIFORNIA CURRENT MOORED ARRAY: LOCAL DYNAMICS AND MIXED LAYER STUDY

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LONG-TERM GOALS

My long-term goals are to quantify and to better understand the dynamics and energetics of the mesoscale in eastern boundary regimes, and to understand the relation between the mixed layer and the mesoscale.

OBJECTIVES

My objectives (within the EBC ARI) are to use the 2-year time series of moored currents and temperatures to 1) determine momentum, energy, and vorticity balances in the California Current System on eddy resolving scales, and to 2) determine the importance of local forcing and its coupling to the ocean interior through the mixed layer.

APPROACH

The observations consist of currents and temperatures measured in the upper 600 meters in the California Current System on eddy resolving scales from current meter moorings deployed in three Local Dynamics Arrays (LDAs). Each LDA consisted of five moorings: four moorings forming a square around a central mooring, with instruments located at 100, 150, 300 and 600 meters depth. Mooring separation was about 15 km. These arrays were deployed off of Point Arenas, CA. The first array was centered on the continental slope, the second one was in deep water adjacent to the slope LDA, and the third LDA was approximately 400 km offshore. Collaborators on the California Current Moored Array (CCMA) are P. Niiler, R. Smith, M. Kosro, and S. Ramp. Additionally, at the center of the offshore LDA, a surface mooring instrumented with a suite of meteorological sensors (wind, air and water temperature, humidity, solar radiation), subsurface temperature sensors, and currents from a downward-looking acoustic Doppler current profiler (ADCP) was deployed for a period of 15 months in order to directly measure local forcing and the mixed layer. Collaborators on the mixed layer mooring are P. T. Strub, C. Paulson, and D. Pillsbury. Additional spatial information is available from satellite (AVHRR and altimeter) and from large-scale surveys made in the summer of 1993.

WORK COMPLETED

Time series, spectra, and progressive vector plots of the moored currents and temperatures have been made. The kinetic energy has been examined as a function of frequency and geographic location, and a preliminary calculation of the momentum and vorticity balances for each of the LDAs has been carried out. The spatial variation of the mean and fluctuating fields and the spatial modes of variability through EOF analysis has been examined. A workshop was held in March of 1997 at SIO to discuss individual results and to foster collaboration and synthesis. Results on the wind-driven flow and the mixed layer at the offshore site have already been published (Chereskin, 1995). Two manuscripts are in preparation (Chereskin et al., 1997; Cornuelle et al., 1997).

RESULTS

We have achieved a first order classification and description of the eddies observed during the EBC program. In broad terms, they are classified as cyclones, anticyclones, and Cuddies. The cyclonic eddies that we observed were cold, shallow (within the top 150 m), and strongly influenced by wind and surface currents. In contrast, the anticyclones had a much longer vertical decay scale, extending down to the thermocline. They were warm, deep (to 800 m), and less dominated by surface flows. A class of anticyclones (termed Cuddies in analogy to Meddies) were highly nonlinear and highly spicey. They were observed to transport anomalous water of equatorial origin (brought north by the California Undercurrent) far offshore (400 km). In the region 36-40.5°N, the monthly maximum in eddy kinetic energy was observed to migrate westward to about 128°W on a seasonal time scale, with maximum values in summer/fall (Kelly et al., 1997). There is a shift to lower frequency as one moves offshore, and a lower incidence of eddy observations (Chereskin et al., 1997).

IMPACT/APPLICATIONS

The EBC experiment has documented the spatial modes of variability, the seasonal cycle, and the offshore propagation of the mesoscale through an unprecedented set of moored, survey, drifter, and satellite observations (e.g., Strub et al., 1997; Kelly et al., 1997; Chereskin et al., 1997). A key finding is that the region of high mesoscale variability appears tightly confined to within about 500 km of the eastern boundary. Further work is required to understand the different dynamics and energetics that govern the different classes of eddies observed, and their decay. The long-lived nonlinear Cuddies may well be one of the chief mechanisms for offshore transport of fluid and properties within the California Current System.

TRANSITIONS

The mooring data have been used by Dr. Bruce Cornuelle in a quasi-geostrophic (qg) modelling effort supported by NASA. In fact, the transition has been 2-way in that the data provided the initialization and the verification of the model physics for the region, and the qg modelling effort has enhanced our interpretation of the eddy dynamics (Cornuelle et al., 1997).

RELATED PROJECTS

This project is related to an NSF funded project in the NE Pacific: P17N, a WOCE hydrographic/ADCP/tracer transect that sampled past the moored array during the passage of a Cuddy. The hydrographic survey supplied nutrient and tracer data which unambiguously identified the water transported by the Cuddy as being equatorial in origin, transported northward by the California Undercurrent.

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